NSK2652PCTUS

DESCRIPTION

COUPLING STRUCTURE OF STEERING TORQUE TRANSMITTING MEMBERS FOR STEERING SHAFT

TECHNICAL FIELD

The present invention relates to a coupling structure of torque transmitting members for a steering shaft.

BACKGROUND ART

Various kinds of couplings are used in a steering apparatus of a vehicle, including an elastic shaft coupling, which comprises an elastic member of rubber interposed between, for example, a yoke of a universal joint and a shaft to be inserted in this yoke, thereby absorbing vibration of an engine or a wheel to suppress transmission of the vibration to a steering wheel.

In such an elastic shaft coupling, a torque is transmitted from the shaft to the yoke through the elastic member in a range having a low torque. However, in a range having a high torque, the transmitting is performed upon direct contact of a stopper face which is provided between the yoke and

the shaft.

As shown in Fig. 7A, a stopper plate 3 formed with a cut-away portion 2 and a disc-shaped elastic member 4 are secured to a steering shaft 1, and a flange 5 of an unrepresented yoke is attached to the shaft 1 through a bush 6.

A pin 8 is inserted through the elastic member 4 and the flange 5 of the yoke through a washer 7. An end of the pin 8 on the yoke side is a male thread shaft which is thread-engaged with a nut 9 to be fixed. The other end of the pin 8 is to be brought into contact (engagement) with the cut-away portion of the stopper plate 3.

Accordingly, in the range with low torque, the elastic member 4 transmits, while being elastically deformed, a steering torque by its deforming resistance. On the other hand, in the range with high torque, the other end of the pin 8 transmits, while being brought into contact (engagement) with the cut-away portion 2 of the stopper plate 3, a steering torque directly to the shaft 1 from the flange 5 of the yoke.

Also in case of Fig. 7B, the structure for transmitting the steering torque is the same as that in the above-described case. However, the end of the pin 8 on the yoke side in this case is fixed to the

flange 5 by clinching. In this case also, the pin 8 has a structure with two steps in which it has a large diameter in its part fitted to the elastic member 4 and a small diameter in its part fitted to the flange 5.

Also in case of Fig. 7C, the structure for transmitting the steering torque is the same as that in the above-described case. In this case, however, the elastic member 4 is integrally formed with the washer 7 and the end of the pin 8 on the yoke side is fixed to the flange 5 by clinching. In this case also, the pin 8 has a structure with two steps in which it has a large diameter in its part fitted to the elastic member 4 and a small diameter in its part fitted to the flange 5.

Though not particularly illustrated, there may another structure for fixing the pin 8 to the flange 5 in which an unstepped pin is fixed by clinching or a stepped pin is fixed by a thread engaging means.

Incidentally, there is a demand for reinforcement of the strength of a fixing structure between the pin 8 and the flange 5.

In such a case, the diameter of the pin 8 may be enlarged. In this case, however, there arise problems such that the weight thereof becomes greater and that the diameter can not be enlarged when the

pin interferes with peripheral components. Also in this case, the width of the cut-away portion 2 of the stopper plate 3 has to be increased, which results in an increased size of the whole structure in order to maintain the strength. Further, the diameter of a pin insertion hole of the elastic member 4 has to be enlarged, which may resultantly lead to an enlarged size of the elastic member. Still further, the hole diameter of the flange 5 of the yoke has to be enlarged, which may resultantly lead to an enlarged size of the flange 5. When there is no enlargement of the size or the reinforcement, the strength is deteriorated.

Still, there may be a case that the hardness of the pin 8 is reinforced. In such a case, however, a clinching work may become difficult to perform, or the structure may be easily affected by an impact load, or the manufacturing cost may be widely increased due to an additional thermal processing step of the materials.

SUMMARY OF THE INVENTION

The present invention has been contrived taking the circumstances described above into consideration and an object thereof is to provide a coupling structure of steering torque transmitting members for

a steering shaft which is capable of enhancing the strength of a pin fixing structure, reducing the number of the constituent components, the manufacturing cost and the weight of the structure, and of improving working and assembling performance (that is, reducing the assembling time).

In order to achieve the above object, according to the present invention, there is provided a coupling structure of steering torque transmitting members for a steering shaft for coupling a pair of steering torque transmitting members interposed in a steering shaft, characterized in that:

one of the steering torque transmitting members and the other of the steering torque transmitting members are adapted to transmit a steering torque through a pin;

the one of the steering torque transmitting members has a pin insertion hole provided with a large diameter hole portion, a stepped receiving portion and a small diameter hole portion; and

the pin has a large diameter portion, a stepped portion and a small diameter portion which are respectively engaged with the large diameter hole portion, the stepped receiving portion and the small diameter hole portion of the pin insertion hole.

As described above, according to the present

invention, one of the steering torque transmitting members and the other of the steering torque transmitting members are adapted to transmit a steering torque through a pin, the one of the steering torque transmitting members has a pin insertion hole provided with a large diameter hole portion, a stepped receiving portion and a small diameter hole portion, and the pin has a large diameter portion, a stepped portion and a small diameter portion which are respectively engaged with the large diameter hole portion, the stepped receiving portion and the small diameter hole portion of the pin insertion hole. Thus, the pin and the pin insertion hole respectively have stepped structures, so as to concentrate the stress on the large diameter portion. As a result, it is possible to enhance the strength of the pin fixing structure, to reduce the number of the constituent components, the manufacturing cost and the weight of the structure, and to improve working and assembling performance (that is, reducing the assembling time).

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic side view of the essential portion of a steering apparatus for a car which incorporates therein a coupling structure

according to an embodiment of the present invention;

Fig. 2A and 2B are cross-sectional views of a steering shaft, a yoke of a universal joint, and an elastic shaft coupling interposed therebetween, respectively according to different embodiments of the present invention;

Fig. 3A is a cross-sectional view of a coupling structure between a pin and a flange according to an embodiment of the present invention, and Fig. 3B is a cross-sectional view of a coupling structure between the pin and the flange according to the prior art;

Figs. 4A, 4B and 4C are respectively cross-sectional views of different coupling structures between the pin and the flange according to embodiments of the present invention;

Figs. 5A and 5B are respectively cross-sectional views of different coupling structures between the pin and the flange according to embodiments of the present invention;

Fig. 6A shows a cross-sectional view of the pin and that of a flange according to an embodiment of the present invention, and Fig. 6B is a cross-sectional view of the pin and the flange shown in Fig. 6A, in a state that the pin and the flange are assembled; and

Figs. 7A, 7B and 7C are respectively cross-

sectional views of different coupling structures between the pin and the flange according to the prior art.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Description will be made on a steering apparatus for a vehicle which incorporates therein an elastic shaft coupling employing a coupling structure of steering torque transmitting members according to an embodiment of the present invention, with reference to drawings.

Fig. 1 is a side view of the essential portion of the steering apparatus for a vehicle which incorporates therein the coupling structure according to an embodiment of the present invention.

As shown in Fig. 1, an intermediate shaft 103 is coupled to a lower end of a main shaft 101 which is coupled to a steering wheel (not shown) through an upper universal joint 102, while an input shaft 105 of a gear apparatus (not shown) is coupled to a lower end of the intermediate shaft 103 through a lower universal joint 104.

Description will be made below on a coupling structure of torque transmitting members for a steering shaft according to an embodiment of the present invention, with reference to drawings.

(Embodiments shown in Figs. 2A and 2B)

Figs. 2A and 2B respectively illustrate different embodiments of the present invention, representing cross-sectional views of a steering shaft, a yoke of a universal joint, and an elastic shaft coupling interposed therebetween.

As shown in Fig. 2A, the steering shaft 1 and the yoke 11 of the universal joint 11 are coupled to each other through an elastic universal joint.

A stopper plate 3 having a cut-away portion 2 which is open outward in the radial direction and a disc-shaped elastic member 4 are secured to the steering shaft 1, while a flange 5 of the yoke 11 is attached to the shaft 1 through a bush 6.

A pin 8 is inserted through the elastic member 4 and the flange 5 through a washer 7. An end of the pin 8 on the side of the yoke 11 is fixed by clinching. Specifically, the washer 12 is attached to the flange 5 by welding, pressure contact, bolt fastening, bonding, or the like, and the end of the pin 8 on the side of the yoke 11 is fixed by clinching through this washer 12.

The other end of the pin 8 is arranged to be brought into contact (engagement) with the cut-away portion of the stopper plate 3.

Accordingly, in a range with low torque, the

elastic member 4 transmits, while being elastically deformed, a steering torque by its deforming resistance. On the other hand, in a range with high torque, the other end of the pin 8 transmits, while being brought into contact (engagement) with the cut-away portion 2 of the stopper plate 3, a steering torque directly to the shaft 1 from the flange 5 of the yoke.

As to be described more specifically later, the flange 5 has a pin insertion hole which is formed with a large diameter hole portion, a stepped receiving portion and a small diameter hole portion, while the pin 8 has a large diameter portion, a stepped portion and a small diameter portion which are respectively to be engaged with the large diameter hole portion, the stepped receiving portion and the small diameter hole portion of the pin insertion hole.

As shown in Fig. 2B, in the present embodiment, the pin insertion hole portion 4a of the elastic member 4 is formed to be cylindrical, and the washer 7, though not shown in the drawing, may or may not be used.

The flange 5 further has a pin insertion hole which is formed with a large diameter hole portion, a stepped receiving portion and a small diameter hole

portion, while the pin 8 has a large diameter portion, a stepped portion and a small diameter portion which are respectively corresponding to the large diameter hole portion, the stepped receiving portion and the small diameter hole portion of the pin insertion hole. (Embodiments shown in Figs. 3A and 3)

Fig. 3A is a cross-sectional view of a coupling structure between a pin and a flange according to an embodiment of the present invention, while Fig. 3B is a cross-sectional view of a coupling structure between the pin and the flange according to the prior art.

As shown in Fig. 3B, in case of the prior art, an end of a pin 8 with two steps is clinched to the flange 5. It is arranged such that stress is concentrated in portions enclosed with circles.

As shown in Fig. 3A, in an embodiment of the present invention, the flange 5 has a pin insertion hole which is formed with a large diameter hole portion 21, a stepped receiving portion 22 and a small diameter hole portion 23, while the pin 8 has a large diameter portion 31, a stepped portion 32 and a small diameter portion 33 which are respectively to be engaged with the large diameter hole portion 21, the stepped receiving portion 22 and the small diameter hole portion 23 of the pin insertion hole.

Since the pin 8 and the pin insertion hole are respectively in stepped structures as described above so that the stress can be concentrated in the large diameter portion, it is possible to enhance the strength of the pin fixing structure.

In case of the present embodiment shown in Fig. 3A, the stress concentrated portions enclosed with the circles are generated in the large diameter portion so that a stress value can be reduced and the strength of the pin can be enhanced.

Since the outer side of the small diameter portion 23 of the flange 5 is embossing-shaped, the thickness of the flange 5 can be reduced.

Further, the large diameter portion 31 of the pin 8 is press fitted in the large diameter hole portion 21 of the flange 5. However, though the small diameter portion 33 of the pin 8 is press fitted in the small diameter hole portion 23 of the flange 5 in the above case, it is suffice if only inserting the small diameter portion 33 therein (with a clearance).

F denotes a repeated load from the stopper plate 3. In case of the structure shown in Fig. 3A, it is possible to further suppress flexure of the pin with respect to F.

Moreover, in case of the prior art shown in Fig.

3B, the top of the hole for clinching and the flange 5 overlap each other so that the rigidity or the strength thereof is decreased. However, in the present embodiment, since the top of the hole for clinching and the flange 5 do not overlap each other, it is possible to obtain high rigidity and strength. (Embodiments shown in Figs. 4A to 4C)

Figs. 4A, 4B and 4C are respectively cross-sectional views of coupling structures between the pin and the flange according to different embodiments of the present invention.

As shown in Fig. 4A, in the present embodiment, the flange 5 has a pin insertion hole which is formed with a large diameter hole portion 21, a stepped receiving portion 22 and a small diameter hole portion 23, while the pin 8 has a large diameter portion 31, a stepped portion 32 and a small diameter portion 33 which are respectively to be engaged with the large diameter hole portion 21, the stepped receiving portion 22 and the small diameter hole portion 23 of the pin insertion hole. Since the pin 8 and the pin insertion hole are respectively in stepped structures as described above so that the stress can be concentrated in the large diameter portion, it is possible to enhance the strength of the pin fixing structure.

As shown in Fig. 4B, the outer side of the small diameter portion 23 of the flange 5 may be embossing-shaped, so that the thickness of the flange 5 can be reduced.

As shown in Fig. 4C, an end of the pin 8 may be formed as a male thread shaft and may be thread engaged with and fixed by a nut 9.

(Embodiments shown in Figs. 5A and 5B)

Figs. 5A and 5B are respectively cross-sectional views of coupling structures between the pin and the flange according to different embodiments of the present invention.

In case of the embodiment shown in Fig. 5A, the flange 5 has a pin insertion hole which is formed with a large diameter hole portion 21, a stepped receiving portion 22 and a small diameter hole portion 23, while the pin 8 comprises a large diameter portion 31, a stepped portion 32 and a small diameter portion 33 which are respectively to be engaged with the large diameter hole portion 21, the stepped receiving portion 22 and the small diameter hole portion 23 of the pin insertion hole. Since the pin 8 and the pin insertion hole are respectively in stepped structures as described above so that the stress can be concentrated in the large diameter portion, it is possible to enhance the strength of

the pin fixing structure.

In addition, the outer side of the small diameter portion 23 of the flange 5 is embossing-shaped, so that the thickness of the flange 5 can be reduced.

Further, the large diameter portion 31 of the pin 8 is press fitted in the large diameter hole portion 21 of the flange 5. However, though the small diameter portion 33 of the pin 8 is press fitted in the small diameter hole portion of the flange 5, it is suffice if only inserting the small diameter portion 33 (with a clearance) therein.

F denotes a repeated load from the stopper plate 3. In case of the structure shown in Fig. 4A, it is possible to further suppress the flexure of the pin with respect to F.

In case of the embodiment shown in Fig. 5B, an inclined hole portion 24 is formed between the stepped receiving portion 22 and the small diameter hole portion 23, and an inclined portion 34 corresponding to the inclined hole portion 24 is formed between the stepped portion 32 and the small diameter portion 33. Other arrangements in this embodiment are the same as those in the foregoing embodiments.

(Embodiment shown in Figs. 6A and 6B)

Fig. 6A is a cross-sectional view of a pin and that of a flange according to an embodiment of the present invention, and Fig. 6B is a cross-sectional view of the pin and the flange shown in Fig. 6A, in a state that the pin and the flange are assembled.

In case of the embodiment shown in Figs. 6A and 6B, the large diameter portion 31 of the pin 8 is press fitted in the large diameter hole portion 21 of the flange 5. However, though the small diameter portion 33 of the pin 8 is press fitted in the small diameter hole portion of the flange 5, it is suffice if only inserting the small diameter portion 33 therein(with a clearance).

Note that the length of the press fitted portion is preferably not less than 5% of the thickness of the flange plate, and most preferably not less than 30% thereof. An interference between the pin and the flange hole is not less than 0.005 mm, and most preferably in a range from 0.05 to 0.5 mm. The length of the portion A (the distance from the stepped receiving portion of the pin to the bottom of the clinching hole) in Figs. 6A and 6B is not less than 0.5 mm, and is preferably not less than 2 mm. A value which is recommended for clinching may be used as a value for the hardness of the thermal processing of the pin, which is preferably in a range from HV

100 to HV 400. The diameter of the press fitted portion of the pin is not less than φ4, and preferably in a range from φ8 to φ20. When the maximum shearing stress acting on the pin in the present embodiment is compared with that in the conventional structure by numerical analysis under the normal use condition, it is confirmed that about 70% of the stress is decreased.

Note that the present invention is not limited to the foregoing embodiments, but can be altered in variable manners.

As described above, according to the present invention, one of the steering torque transmitting members and the other of the steering torque transmitting members are adapted to transmit a steering torque through a pin, one of the steering torque transmitting members has a pin insertion hole which is formed with a large diameter hole portion, a stepped receiving portion and a small diameter hole portion, and the pin has a large diameter portion, a stepped portion and a small diameter portion which are respectively to be engaged with the large diameter hole portion, the stepped receiving portion and the small diameter hole portion of the pin insertion hole. Thus, the pin and the pin insertion hole respectively have stepped structures, so as to

concentrate the stress on the large diameter portion. As a result, it is possible to enhance the strength of the pin fixing structure, to reduce the number of the constituent components, the manufacturing cost and the weight of the structure, and to improve working and assembling performance (that is, reducing the assembling time).